



Short Communication

First record of folivory on a newly documented host plant for the little known geometrid moth *Eupithecia yubitzae* Vargas & Parra (Lepidoptera, Geometridae) in northern Chile

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ABSTRACT

The native tree *Schinus molle* (Anacardiaceae) is reported for the first time as a host plant for larvae of the little known geometrid moth *Eupithecia yubitzae* Vargas & Parra (Lepidoptera, Geometridae) in the Atacama Desert of northern Chile, based on morphology and DNA barcodes. This discovery importantly expands the host range of *E. yubitzae*, as previous records were restricted to Fabaceae trees. Larvae were previously known as florivorous, while these were found to be folivorous on *S. molle*. Furthermore, host-associated cryptic larval polychromatism was detected, as larvae collected on *S. molle* were found to be mostly pale green, contrasting with the dark yellow ground color of the larvae typically collected on fabaceous host plants.

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Eupithecia Curtis, 1825 is a hyper-diverse moth genus of Larentiinae (Geometridae) with a broad distribution range (Scoble, 1999; Mironov and Galsworthy, 2012). More than 350 species have been described from the Neotropical Region (Herbulot, 2001), but certainly many others are waiting to be collected and studied. The small size, cryptic coloration and the little interspecific wing pattern variation in the adult stage impede accurate diagnosis based on wing maculation only; thus species level identification regularly requires dissection of the genitalia (Rindge, 1987).

Although the biology of a large number of species of *Eupithecia* remains unknown, phytophagy is the most widespread habit among its larvae. Host plants are better recorded for the Nearctic and Palearctic faunas, with Asteraceae and Pinaceae among the most important families (Robinson et al., 2010). A remarkable exception to the phytophagy has been reported for many species endemic to the Hawaiian Islands, whose larvae are characterized by an ambush predator behavior (Montgomery, 1982).

Unfortunately, the biology of Neotropical *Eupithecia* has been little studied and only a few host plant records are currently available, which indicate associations with Chenopodiaceae, Dennstaedtiaceae, Ericaceae, Fabaceae, Gunneraceae and Myricaceae (Ibarra-Vidal and Parra, 1993; Parra and Ibarra-Vidal, 2002;

Vargas and Parra, 2002, 2004, 2005; Bodner et al., 2010). Larvae are mostly external feeders on flowers or leaves (Vargas and Parra, 2002, 2004, 2005; Vargas et al., 2002; Bodner et al., 2010), or may be internal feeders such as petiole borers (Ibarra-Vidal and Parra, 1993; Parra and Ibarra-Vidal, 2002).

More than 60 species of *Eupithecia* have been recorded from Chile, many of which are endemic to the south-central zone of this country (Rindge, 1987, 1991; Herbulot, 2001; Parra and Ibarra-Vidal, 2002; Vargas and Parra, 2004, 2005; Vargas, 2011a). However, host plants have been recorded only for six Chilean species (Ibarra-Vidal and Parra, 1993; Parra and Ibarra-Vidal, 2002; Vargas and Parra, 2002, 2004, 2005; Vargas et al., 2002).

Eupithecia yubitzae (Vargas and Parra, 2004) is a little known geometrid moth described from the coastal valleys of the Atacama Desert of northern Chile, where the only available rearing records indicate two native fabaceous trees as hosts, *Acacia macracantha* Willd. and *Prosopis tamarugo* Phil., in which the larvae feed on inflorescences (Vargas and Parra, 2004, 2009). The objective of this study is to report a new host plant record and the first record of folivory for larvae of this little known geometrid moth.

As a part of a study of Lepidoptera associated with the vegetation of the coastal valleys of northern Chile, geometrid larvae were collected on the native tree *Schinus molle* (Anacardiaceae) in July 2013 in the Chaca Valley, Arica Province, which were brought to the Laboratorio de Entomología, Universidad de Tarapacá, Arica, in plastic vials. The vials were periodically cleaned and additional leaves were

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provided until last instar larvae finished feeding, and then pieces of towel paper were placed on the bottom of the vials to allow pupation. Some pupae were kept in 95% ethanol for further study, while remainders were observed daily until adult emergence. In order to provide a taxonomic identification based on morphology, adults were mounted and male ($n=2$) and female ($n=2$) genitalia were dissected and slide mounted according to standard procedures. Subsequently, in March 2014 some larvae of *E. yubitzae* were collected on inflorescences of *A. macracantha* in the Azapa Valley, Arica Province, and similar procedures to those described for larvae collected on *S. molle* were followed to obtain pupae and adults.

As morphological features of the adult stage suggested that the same species was feeding on the two hosts (see below), a molecular identification was performed following the procedures described in Atashpaz et al. (2010) and Li et al. (2010) for genomic DNA extraction, and Vargas et al. (2014) for PCR amplification of the DNA barcode fragment of the cytochrome oxidase subunit 1 (COI) gene from pupae reared from larvae collected on *S. molle* and *A. macracantha*, using the primers LEP-F1 (5'-ATTCAACCAATCATAAAGATAT-3') and LEP-R1 (5'-TAAACTTCGTGGATGTCCAAAAA-3') developed by Hebert et al. (2004). Reactions containing fragments of the expected size were directly sequenced by a commercial facility (Macrogen, South Korea). The software MEGA6 (Tamura et al., 2013) was used to align the sequences by the MUSCLE method (Edgar, 2004) and to calculate the sequence divergence with the Kimura 2-parameter model (Kimura, 1980).

Adults obtained from folivorous larvae on *S. molle* and from florivorous larvae on *A. macracantha* were identified as *E. yubitzae* based on morphology of the male and female genitalia, according to original descriptions and figures (Vargas and Parra, 2004). Furthermore, two DNA barcode sequences were obtained from pupae coming from larvae collected on *A. macracantha* ($n=1$; 658 bp; GenBank accession KP064220) and *S. molle* ($n=1$; 611 bp; GenBank accession KP064219). The genetic divergence between them was 0.2% (K2P), as only one site was variable due to the presence of a substitution of the transition type. The low genetic variation observed between the two sequences suggests that both specimens belong to the same species, regardless of the host plant used, confirming the identification provided by the morphological analysis. A detailed knowledge of the host–plant relationships is an important issue to reach a sound understanding of the biodiversity, ecology and evolution of phytophagous insects in tropical environments (Bodner et al., 2010). Accordingly, data providing new insights on the host range and larval feeding behavior of little known species are helpful as these contribute to build up adequate databases for subsequent analyses.

This is the first report of an Anacardiaceae host plant for *E. yubitzae*, which importantly expands the host range of this geometrid moth, as previous records were restricted to Fabaceae (Vargas and Parra, 2004, 2009). Interestingly, all the collected larvae went through 1–3 ecdyses before pupation during the laboratory rearing, suggesting effective use of the respective host plant and ruling out an eventual wrong host record. Also, the *S. molle* trees on which the larvae were collected in the Chaca Valley were isolated from any *A. macracantha* tree, and the *A. macracantha* tree was isolated from any *S. molle* tree in the Azapa Valley.

Host plant use in Lepidoptera is an extremely complex issue, but it is mostly determined by the ability of the females to recognize a plant as adequate, and by the ability of the larvae to complete development on the plant selected by the female (Stefanescu et al., 2006). Host plant range in Geometridae can be from narrow to broad (Robinson et al., 2010). It has been suggested that host ranges are narrower in Neotropical than in Nearctic species at least in two other geometrid genera (Poole, 1987; Vargas, 2011b, 2014). Regarding *Eupithecia*, many Nearctic and Palearctic species are

known to be polyphagous (Bolte, 1990; Scoble, 1999; Robinson et al., 2010), while in the few cases in which records are available for Neotropical species the hosts are restricted to a single plant genus or family (Ibarra-Vidal and Parra, 1993; Parra and Ibarra-Vidal, 2002; Vargas and Parra, 2002, 2004, 2005; Bodner et al., 2010). Accordingly, *E. yubitzae* would be the first Neotropical *Eupithecia* that has been reared from plants belonging to more than one family, suggesting a broad host range. Unfortunately, as the records available are extremely restricted, it is not possible to generalize in relation to host plant use patterns in the Neotropical *Eupithecia*, thus additional sampling is required to characterize better the host range of these species.

Another remarkable aspect is that *E. yubitzae* larvae typically feed on inflorescences of their fabacean hosts (Vargas and Parra, 2004, 2009), while these were found to be folivorous on *S. molle*, providing the first record of folivory for this little known geometrid moth. Furthermore, larvae of *E. yubitzae* feeding on inflorescences of its fabacean hosts are typically mostly dark yellow with a dark reddish brown dorsal stripe on the thorax and the abdomen; the ground color of the larvae collected on *S. molle* was pale green, although with a similar dorsal stripe, providing an example of host-associated cryptic larval polychromatism.

In general, flowers and leaves represent different feeding substrates for phytophagous insects, as their nutritive properties can be very different (Chew and Robbins, 1984). However, occasional feeding on flowers by folivorous lepidopterans has been previously recorded, and this has been qualified as an opportunistic behavior (Diniz and Morais, 2002; Smallegange et al., 2007; Morais et al., 2009).

In the case of *E. yubitzae* it remains unknown whether *A. macracantha*, *S. molle* or still another plant would be the primary host, and it is also unknown whether folivory or florivory is the primary feeding behavior of its larvae. Accordingly, further studies are required to characterize better the host plant range and feeding behavior of this little known moth. In addition, as cryptic larval polychromatism and polyphagy may be advantageous for lepidopterans (Monteiro, 1991), the eventual ecological and evolutionary consequences of the host-associated color patterns here mentioned for larvae of *E. yubitzae* deserve further attention.

Vouchers will be deposited in the Museo Nacional de Historia Natural de Santiago, Santiago, Chile (MNNC) and in the Colección Entomológica de la Universidad de Tarapacá, Arica, Chile (IDEA).

Material examined. Chile. Arica. Four males, four females Chaca, Arica, Chile, August 2013, H.A. Vargas coll., reared from folivorous larva on *S. molle*, July 2013. Two males, two females Azapa, Arica, Chile, April 2014, H.A. Vargas coll., reared from florivorous larva on *A. macracantha*, March 2014.

Conflicts of interest

The authors declare no conflicts of interest.

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